INSTRUCTION MANUAL

NO. 6402

BARBER COLMAN

Wheelco Instruments

model 402 CAPACITROL

0 - 1600°F C/A

0 - 600°F

MP MASTER

MA32123

WHEELCO INSTRUMENT DIVISION
BARBER-COLMAN COMPANY, ROCKFORD, ILLINOIS

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NOTE: This instruction manual to be given to persons responsible for installation and maintenance of this instrument.

UNPACKING INSTRUMENT

This Wheelco Instrument and its associated equipment have been carefully manufactured and packed at the factory. Remove the instrument and accessories from the packing box and check items against the packing slip. If the equipment is found to be damaged in transit, report extent of damage to the carrier immediately. Repack in original packing box until ready for installation.

CAUTION:

Handle with care.

Safeguard instrument from shock.

Avoid oil accumulation.

Keep instrument temperature under 130° F.

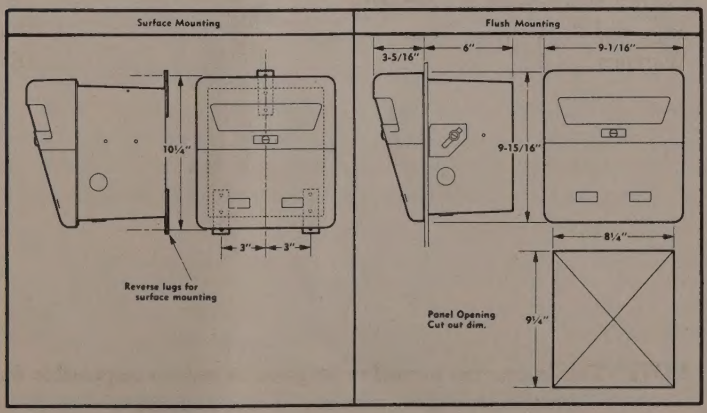
MOUNTING INSTRUCTIONS

Locate the instrument to avoid shock, excessive vibration, moisture and temperatures over 130° F. Avoid furnace walls, radiation of heat, machine frames and outside walls. Provide suitable shelter to avoid moisture and temperature extremes if installed outdoors.

For surface mounting, reverse the three lugs on the back of the instrument housing. See the mounting surface mounting dimension drawing.

For flush or panel mounting, remove the brackets on either side of the instrument housing, insert the instrument through the panel opening, replace the brackets and tighten firmly. See the flush mounting dimension drawing.

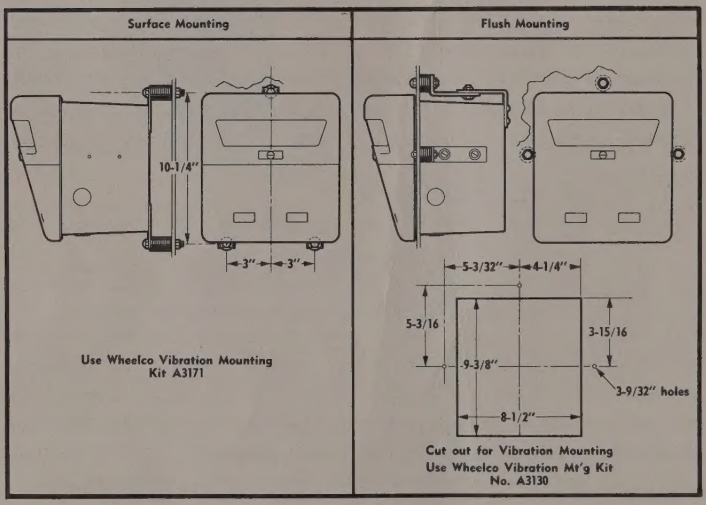
MOUNTING DIMENSIONS



Vibration mounting kits should be used if the vibration causes erratic temperature readings or control. See the vibration mounting dimension drawing for details of surface or flush mounting. Special provisions may have to be considered if the instrument is subjected to severe shock such as from a drop forge or similar type of equipment.

Moderate care should be taken to mount the instrument level.

MOUNTING DIMENSIONS
Vibration Mountings



POWER WIRING

Remove the lower section of the front cover to expose the terminal strips and the control chassis. To expedite wiring, grasp the side plates of the chassis and pull forward to remove. Check the rating plate on the side of the chassis for the supply voltage and frequency. Connect proper voltage and frequency to terminals L1 and L2. Supply voltage should be 105 to 125 volts AC or 210 to 250 volts AC depending on chassis specifications. Run all wiring in rigid conduit, BX or Greenfield, in accordance with the recommended electrical code. Use properly fused switches, see diagram.

The instrument terminals are constructed to insert the wire in the terminal and tighten the binding screw to secure the wire permanently. Solid wire (14 ga.) is recommended for instrument wiring. If stranded wire is used, tin the ends to provide secure connections. Position the wires so they do not interfere with control chassis or the housing gas-

kets. Ground the instrument case; a grounded conduit system is usually sufficient.

THERMOCOUPLE WIRING

Do not run thermocouple lead wire with other power or control wiring except for thermocouple break (TCB) wires, if used. Several thermocouple lead wires may be run in the same conduit if desired.

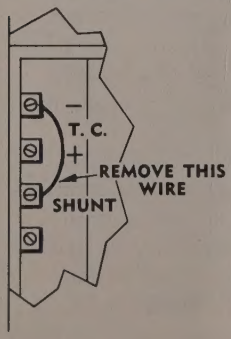
Use only extension lead wire correct for the type of thermocouple (TC) as specified on the scale. The most commonly used types are: Iron-Constantan (I/C), Chromel-Alumel (C/A), Platinum-Platinum 10% Rhodium (Pt/Pt 10% Rh), Platinum-Platinum 13% Rhodium (Pt/Pt 13% Rh) and Heat-Eye. Ordinary copper wire will NOT serve the purpose.

Proper polarity (+) and (—) of the lead wire must be observed to obtain correct readings. The negative wire is usually coded red. Correct polarity of the lead wire can be checked by heating a temporary junction of the lead wire far end. Deflection of the indicator upscale indicates correct polarity of the lead wire.

The thermocouple should then be connected to the lead wire and the indicating pointer should again deflect upscale when the thermocouple hot junction is heated. If the indicator moves downscale, reverse only the connections at the thermocouple head since the lead wire has already been correctly connected to the instrument.

The lead wire may be inserted in the terminal post holes and the binding screw tightened or connected under the screw head if lugs are used. Locate the lead wire so it does not interfere with the control chassis or housing gaskets.

METER SHUNT WIRE



After the instrument is installed, disconnect the jumper wire across terminals "Shunt" and "TC—". This wire is used to shunt or dampen the meter movement for protection during shipping, installation and handling of the instrument but should be removed for normal operation.

NOTE: Replace this shunt wire when handling or reshipping the instrument and position the red control point indicator to the top of the scale.

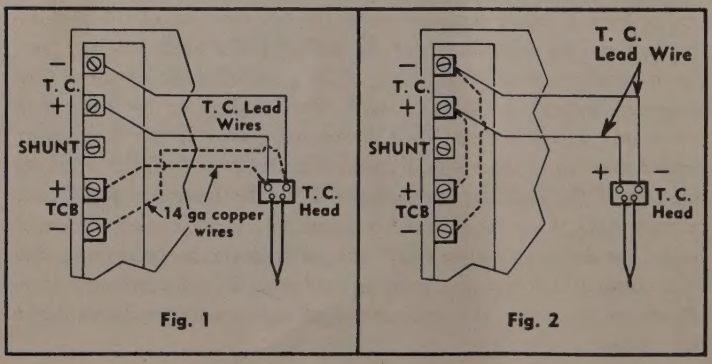
LINE COMPENSATING RESISTOR (A3152)

The external resistance, combined resistance of the extension lead wire and thermocouple, for which the meter has been calibrated is marked on the meter scale. Most meters are calibrated for 15 ohms (Ext. Res. 15 ohms) which is more resistance than most lead wire runs. The balance of the resistance, 15 ohms minus the actual external resistance, will be inserted on a removable resistance strip located just under the meter section. The resistance value is marked on the strip and is inserted at the time of the original order. Other values are available, however, lead wire length can be changed up to 25 ft. without appreciable error in reading because a high resistance movement is used.

THERMOCOUPLE BREAK PROTECTION (TCB)

The instrument is equipped with thermocouple break (TCB) protection. Essentially it is a small DC voltage that can be wired into the thermocouple circuit to drive the movement upscale in case of an open circuit in the thermocouple, thus passing the control set point and causing the instrument control to go to the off position. It is not necessary to make the TCB connections for normal operation of the instrument, but its use may be desirable on some applications to guard against overheating in event of an open thermocouple.

The preferred method of connecting TCB is shown in Fig. 1. Use extension lead wire as required to make the connections between the instrument TC terminals and the thermocouple head. Use 14 gauge copper wire to connect the TCB terminals to the thermocouple head, observing polarity. Wiring for TCB may be run in the same conduit with thermocouple lead wire. As the resistance of the thermocouple is low compared to the resistance of the meter movement, TCB compensation is seldom required.



The optional method of connecting TCB is to use jumpers at the instrument terminals as shown in Fig. 2. As the length of lead wire used affects the amount of TCB compensation required, it is suggested that this method be used with short lead wire lengths, 10 ft. or less and that the amount of TCB error be checked.

To check for TCB operation, disconnect the thermocouple to simulate a broken thermocouple but leave the TCB wires connected to the lead wire. When the instrument is powered, the indicator should drive upscale above the red control set pointer to cause the control to go to the off position.

TCB is not effective on Heat Eye (radiation head) calibrations because of the compensating network in the Heat Eye.

METER ADJUSTMENTS AND CHECK

After the instrument is mounted, check for the cold junction reading of the meter. Disconnect the lead wire at the instrument. The indicator should come to rest at the ambient temperature of the meter; it is NOT supposed to read zero. Place a thermometer at the TC instrument terminals to read ambient temperature.

If the pointer does not come to rest at the ambient temperature, slowly adjust the screw located on top of the front plastic cover. As the meter has automatic cold junction compensation, it is not necessary to make further corrections as the ambient temperature changes.

To check for thermocouple break error (TCB) if it is connected, it is best to have a steady temperature at the hot junction of the thermocouple. Read the temperature at the indicator. For exact reading, position the eye so the reflected image of the pointer on the mirrored strip disappears behind the pointer itself. This reading to be made with power on the instrument. Then disconnect power to the instrument, remove the control chassis, or disconnect the wires at the TCB terminals and note if the indicated temperature drops. Reconnect to see if temperature rises. If a shift in reading is noticed, usually a small amount if any, adjust the screw on the top of the plastic cover, so the reading with TCB powered is at the same point as read with TCB disconnected. If an adjustment was made, the ambient temperature reading will also shift a like amount.

DESCRIPTION OF ELECTRONIC CIRCUIT

The Model 402 Controller is a development based on the original Wheelco "Electronic Link". It employs a simple tuned grid, tuned cathode oscillator as a means of translating process requirements (as measured by the indicator) to control action such as to keep the process at optimum conditions or at the set control point.

The temperature (or other variable being measured) is indicated on a calibrated scale by a pointer to which is attached a lightweight metallic vane called the flag. The flag is free to pass between the oscillator or pick-up coils which are mounted on an externally adjustable control setting arm. Position of control setting arm is indicated on the calibrated scale by means of the red index representing the control set point. Thus, the position relationship between the flag and the oscillator coil is representative of the relationship between the measured value and a desired control value.

As the flag moves within the field of the pick-up coils, it influences the oscillator circuit to tune or de-tune it which, in turn, regulates the power output to energize or de-energize the control relay. Thus, the Model 402 is basically an on-off controller but, as described under Control Specifications, it has been refined to incorporate a time-proportioning system which permits adjustment of rate and amplitude of control cycle time or "anticipating" action.

CONTROL SPECIFICATIONS

The Model 402 Truline Controller takes advantage of the flexibility of the tank portion of the oscillator circuit to provide control characteristics equivalent to those of the well-known Wheelco Capaciline, but in a more direct manner and without disturbing or off-setting a measuring circuit.

This is accomplished by the use of a thermal time-proportioning unit which is controlled by the load relay contacts and so arranged to influence the tank circuit to swing or shift the output level to offset the actual control point with respect to control set point or red index. Direction of shift is determined by position of the relay contacts; that is, if the indicator is below control set point, actual control point is reset downscale and vice versa. Rate and amplitude of shift of control band is adjustable to meet the requirements of process and controlled equipment characteristics. For a more complete and detailed description of this and other Wheelco control systems, ask for Educational Bulletin No. 9.

PROPORTIONAL CONTROL AND MANUAL RESET

Even though the Model 402 Controller is basically an on-off controller, the introduction of the Truline time-proportioning device creates a measurable proportioning band. The width of this proportioning band is adjustable from ½ of 1% to approximately 5% of scale range. The principle of operation of the Truline is such that the width of the proportioning band is inversely proportional to the cycling rate. The cycling rate is adjustable from a minimum of approximately forty (40) seconds to a maximum of four (4) seconds as measured with the thermocouple terminals shunted. Thus, with the cycling rate set at maximum (approximately four (4) seconds), the proportioning band will effectively be approximately 5% of scale and vice versa.

The Model 402 will be subject to "droop" or offset. A manual resetting device is provided on the control chassis for "droop" correction.

CONTROL ADJUSTMENTS

For the initial start-up, set the time-proportioning adjustment at its maximum counter-clockwise position. This adjusting knob is located to the right of the control relay on the control chassis and is accessible after removing the lower control compartment cover. The time-proportioning dial is calibrated "A" through "I" in a clockwise direction. Position "A" is equivalent to an "off" position and when set at "A" will operate as a conventional on-off controller. Turning the time-proportioning adjustment knob to "B", to "C" and so on in a clockwise direction will increase the control cycling rate and widen the proportioning band.

As stated previously, the time-proportioning knob should be turned to its extreme counter-clockwise position for the initial start-up. With the instrument powered, a "reset" adjustment should then be made so that the control relay is energized when the indicating pointer is below the red index and de-energized when the indicating pointer is above the red index. The "reset" adjustment is located on the control chassis just below the time-proportioning adjustment knob and must be made by means of a small screwdriver. The pilot signal lamps will indicate the position of the control relay. When the control relay is energized, the left-hand (red) lamp is lighted and when de-energized the right-hand (green) lamp is lighted.

After the initial time-proportioning and "reset" adjustments have been made, the control setting knob located below the indicating meter should be used to set the red index at the desired control point. The entire system should then be given an opportunity to come up to and

level off to a steady value at the desired control point. No further adjustments should be made to either the time-proportioning or "reset" adjustments until the instrument has been operating at or near the control point for a reasonable length of time or until process conditions have stabilized. After conditions have stabilized, further adjustments may be in order on both the time-proportioning and the "reset" adjustments. However, it is well to ignore the "reset" adjustment until the time-proportioning adjustment has been completed. That is, the "reset" adjustment is required only for a final proper alignment of the indicating pointer and the red index.

Therefore, if the initial setting of the time-proportioning adjustment does not give satisfactory control, corrections should be made by moving the knob in the clockwise direction in small steps. After each adjustment, be sure to give the system sufficient time to stabilize and level off. Final setting of the time-proportioning adjustment will depend upon the refinement and control required and the rate of control relay cycling that can be tolerated. In some cases a slight plus or minus variation in temperature may be permissible and preferred rather than exceptionally fast cycling of the control relay and load contactor. In other cases, it may be desirable to have exceptionally close control even though contact life might be somewhat reduced.

After the time-proportioning adjustment has been found to be satisfactory, the "reset" adjustment should be made in a direction such that the indicating pointer and the red index will be in alignment under normal operating conditions.

EXTERNAL WIRING DIAGRAMS

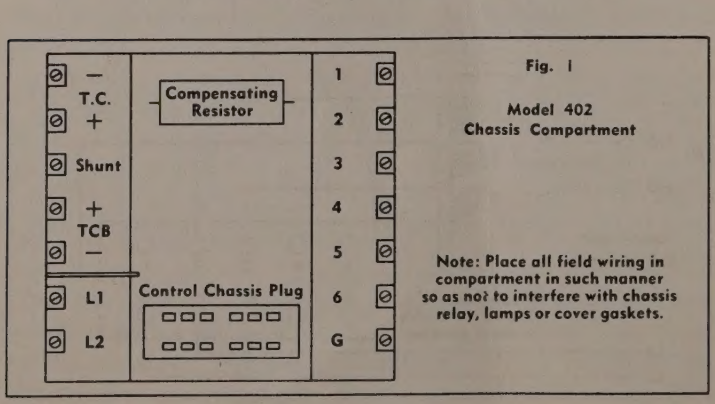


Fig. 1

Model 402
Chassis Compartment

Note: Place all field wiring in compartment in such manner so as not to interfere with chassis relay, lamps or cover gaskets.

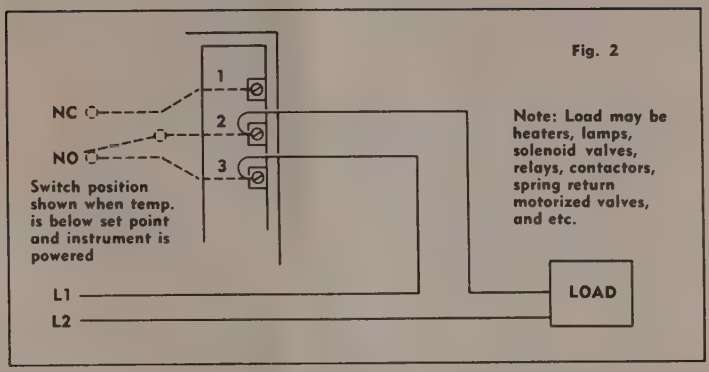


Fig. 2
NC
NO
1
2
3
Switch position shown when temp. is below set point and instrument is powered
Note: Load may be heaters, lamps, solenoid valves, relays, contactors, spring return motorized valves, and etc.
LOAD
L1
L2

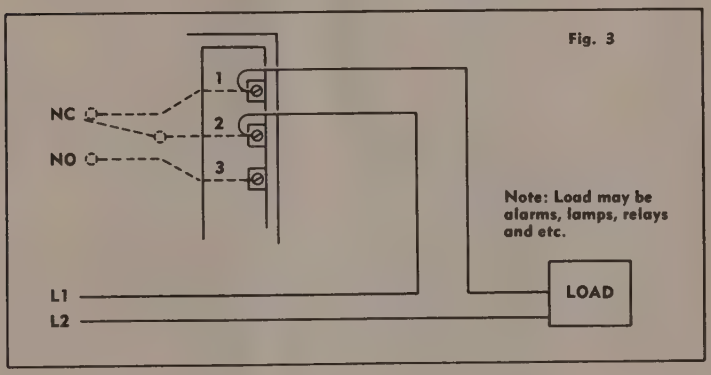


Fig. 3
NC
NO
1
2
3
Note: Load may be alarms, lamps, relays and etc.
LOAD
L1
L2

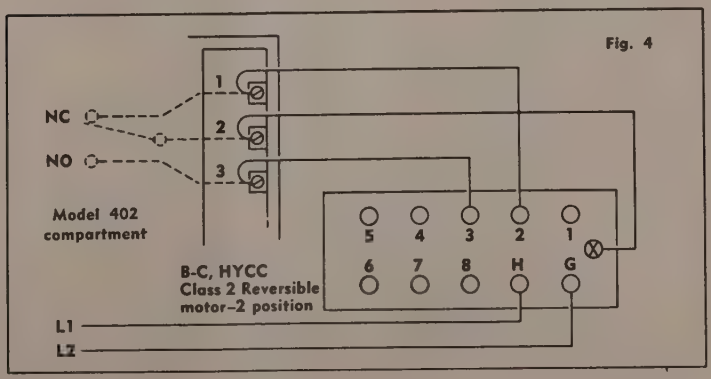
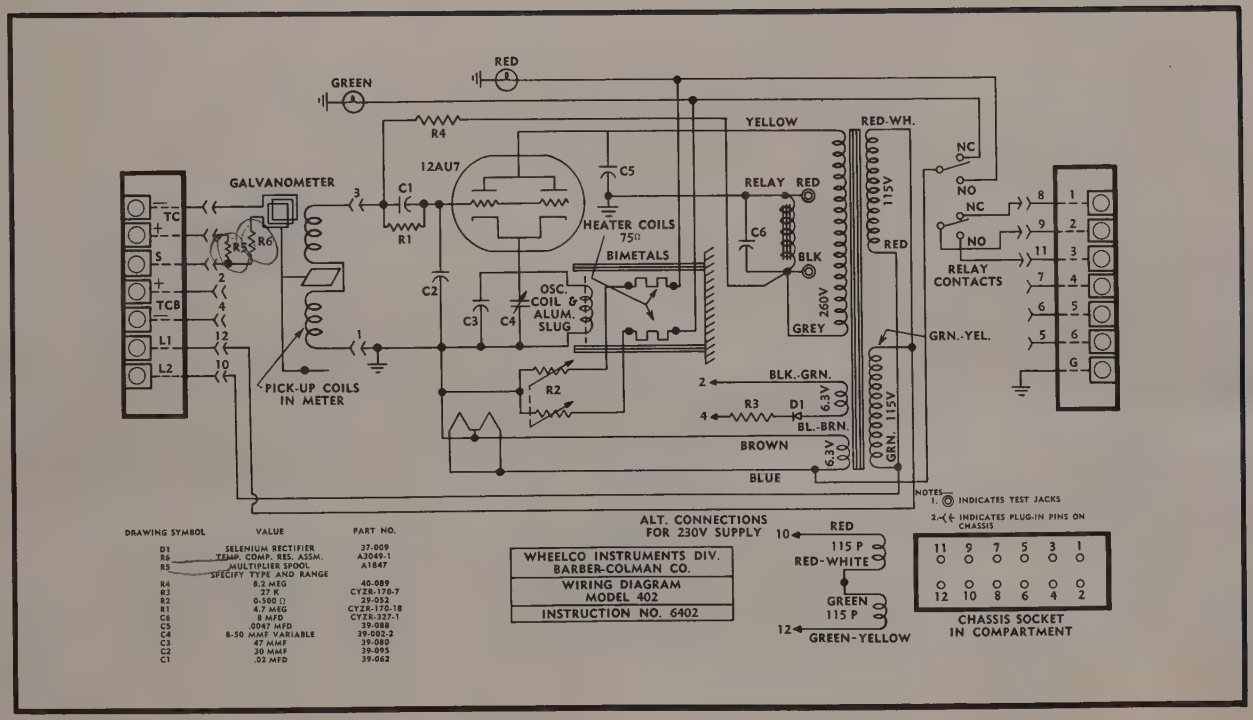


Fig. 4
NC
NO
1
2
3
Model 402 compartment
5
4
3
2
1
6
7
8
H
G
B-C, HYCC Class 2 Reversible motor–2 position
L1
L2



DRAWING SYMBOL	VALUE	PART NO.
D1	SELENIUM RECTIFIER	37-009
R6	TEMP. COMP. RES. ASSM.	A3049-1
R5	MULTIPLIER SPOOL	A1847
	SPECIFY TYPE AND RANGE	
R4	8.2 MEG	40-089
R3	27 K	CYZR-170-7
R2	0-500 Ω	29-052
R1	4.7 MEG	CYZR-170-18
C6	8 MFD	CYZR-327-1
C5	.0047 MFD	39-088
C4	8-50 MMF VARIABLE	39-002-2
C3	47 MMF	39-080
C2	30 MMF	39-095
C1	.02 MFD	39-062

WHEELCO INSTRUMENTS DIV.
BARBER-COLMAN CO.
WIRING DIAGRAM
MODEL 402
INSTRUCTION NO. 6402

METER MAINTENANCE AND SERVICING

While the 400 series instrument is well designed and manufactured of high grade components, it is worthwhile to have information for emergency servicing. Where a number of instruments are located in the same area, many parts are interchangeable and allows a minimum inventory.

In the event of trouble, the serviceman should familiarize himself with the process and instrument application to ascertain the exact function of the instrument as applied. The trouble usually can be traced to two basic problems, measurement or control.

If the measured temperature is known to be in error, check the following:

(1) Open thermocouple circuit, such as break in thermocouple or lead wiring.

(2) Deteriorated T.C. hot junction due to burning.

(3) Shorted, grounded, or damp lead wire or thermocouple except the thermocouple hot junction may be grounded.

(4) Correct polarity of lead wire and thermocouple.

(5) Check for vibration or shock.

(6) A calibration check for meter accuracy can be made with a Wheelco Portable Model 330 or equivalent.

(7) Do not oil or grease any part of the instrument.

In event it is found necessary to remove the plug-in meter assembly, follow these steps:

(A) Remove control set point knob (Bristol No. 6 wrench).

(B) Remove the four cover screws.

(C) Remove cover straight forward to prevent damage to internal meter parts.

(D) Loosen the two screws in lower meter chassis corners.

(E) Insert fingers behind the two lugs and pull forward carefully to avoid sudden jarring.

(F) Place a jumper wire across the prongs on the back of the meter to dampen the movement.

(G) Position the red pointer to top of scale.

(H) As the meter is exposed, avoid dirt and metal chips.

Reassembly is of reverse procedure, being careful to line up the slotted lever for the zero adjustment pin when replacing the meter cover. Recheck for ambient temperature setting as previously described.

CONTROL MAINTENANCE AND SERVICING

If the control does not function properly and the temperature does not stay at the control point, check the following:

(1) Check power to the instrument. Should be 105 to 125 volts AC or 210 to 250 volts AC depending on chassis specifications.

(2) Replace electronic tube. Two jacks on the front of the chassis are provided to read voltage across the relay coil. With the red control index well above the indicator, the DC voltage should read between 85 to 110 volts. When the red index is below the indicator, the reading should be 15 volts or less.

(3) Relay limits can be checked by moving the red control index slowly across the indicator. Relay pull-in voltage is 50 to 65 volts DC, drop-out is 30 to 45 volts DC. These readings can be noted as the signal lights operate.

(4) Replace chassis. Take advantage of the interchangeable plug-in components if other instruments of the same type and voltage are available.

(5) Check external circuit for sticking valves or contactors, fuses, grounded or shorted wiring, etc.

(6) To alter the control chassis in the field for a different line voltage, change the transformer primary connections per the following: (Also see internal wiring diagram)

230 volt:

Red to pin 10 (L2)
Green-Yellow to pin 12 (L1)
Connect Red-White to Green and tape

115 volt:

Red and Green to pin 10 (L2)
Red-White and Green-Yellow to pin 12 (L1)

(7) Tube number 5814 can be used in place of EYZP 70-9 (12AU7) if desired.

(8) Pilot or signal lights are No. 51 Mazda bulbs.

(9) Connect a grounding wire to the "G" terminal if the instrument is ungrounded.

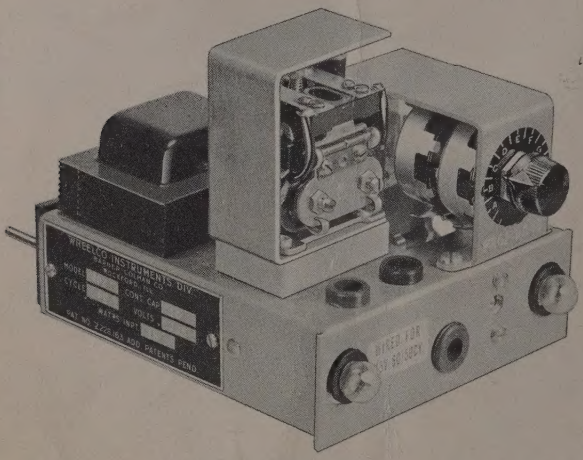
SUGGESTED REPLACEMENT PARTS

It is suggested that a few spare parts be carried by the user to insure against possible emergencies and accidental damage. These are listed in the order of probable relative need:

	Part No.
*Electronic tube 12AU7	EYZP 70-9
Thermocouple	
Mazda pilot lamps (No. 51)	36-022-1
Model 402 Chassis complete with 12AU7 tube for	
115 V/60C	A3359
230 V/60C	A3360
115 V/25C	A3361
230 V/25C	A3362

*NOTE: We recommend purchase of the 12AU7 tube from the Wheelco Instruments Division, Barber-Colman Company, to insure instrument functioning as designed. Tube 5814 can also be supplied.

MATERIAL WARRANTY: All equipment except tubes, photocells, and thermocouples, which within one year from date of shipment is found to have been originally defective, will be repaired (replaced if necessary) free of charge, if returned immediately, prepaid to the factory at Rockford, Illinois. The seller shall not be liable to the purchaser, or to any other person, firm or corporation for any direct, indirect or consequential damages or injury of any kind or character; that by acceptance of such equipment the purchaser shall accept and assume all liability for any and all damages or injuries that may result from the use or misuse of such equipment by the purchaser, or by any other person, firm or corporation; and that there shall be no other warranty whatever, expressed or implied, with respect to such equipment.



Warranty . . .

Please fill out the Warranty and Inspection Card and return, postage paid.

Warranty and Inspection Card — PLEASE FILL OUT AND RETURN

This equipment is guaranteed in accordance with the statement of warranty appearing on our quotation and acknowledgement forms. Upon receipt of this card properly filled out Warranty becomes effective. All Wheelco instruments are manufactured to the highest standards of quality and are carefully inspected before packing. Instruments which have been damaged or fail to operate upon installation, should be reported to the factory at once.

Wheelco Instruments Division
Barber-Colman Company

MODEL NO.	Date Received
	Company
SERIAL NO.	Street
	City Zone State
CALIBRATION INSP.	By Title
FINAL INSPECTION	

F-5396

MP MASTER
MA32123

F-7727